Natural insulation fibres for the absorption of indoor volatile organic compounds

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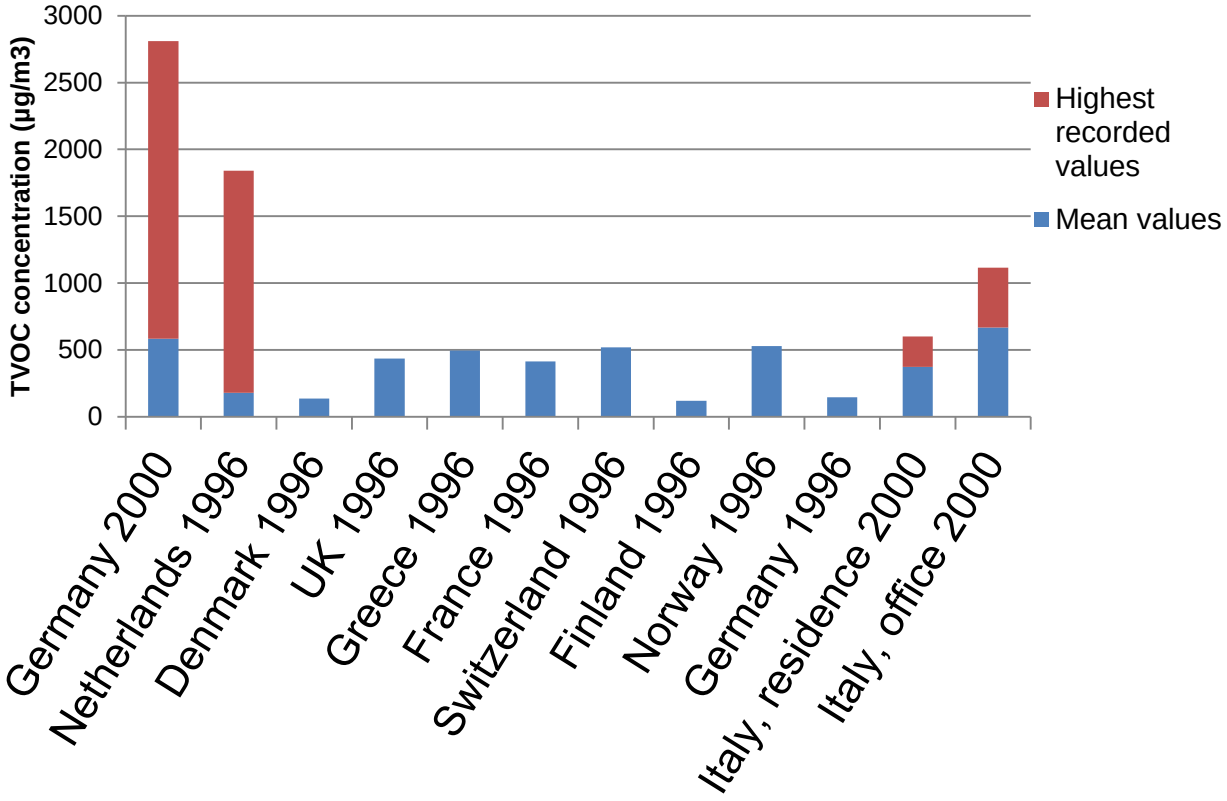
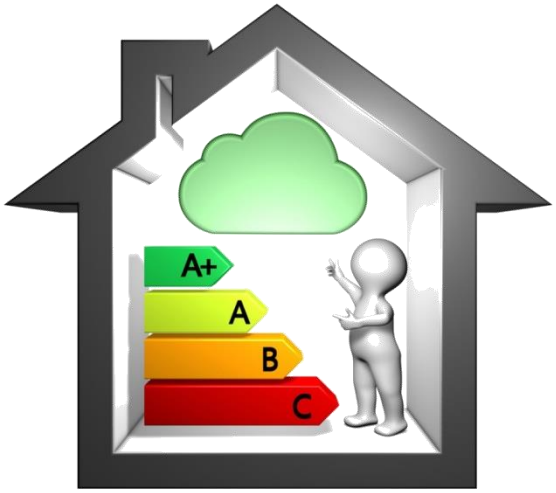
Sick building syndrome

- First noticeable case:1970s, Sweden, in preschools; casein that was emitted from self-levelling cement.
- Several similar cases were thereafter reported:
  - 10,000 Canadian buildings in the mid-1990s
  - Cost of ≈$1 million at EPA U.S. headquarters due to decreased productivity

WALLACE, L.A. (2001): Human Exposure to Volatile Organic Pollutants: Implications for Indoor Air Studies: Annu. Rev. Energy Environ. 26: 269–301

What's the problem?





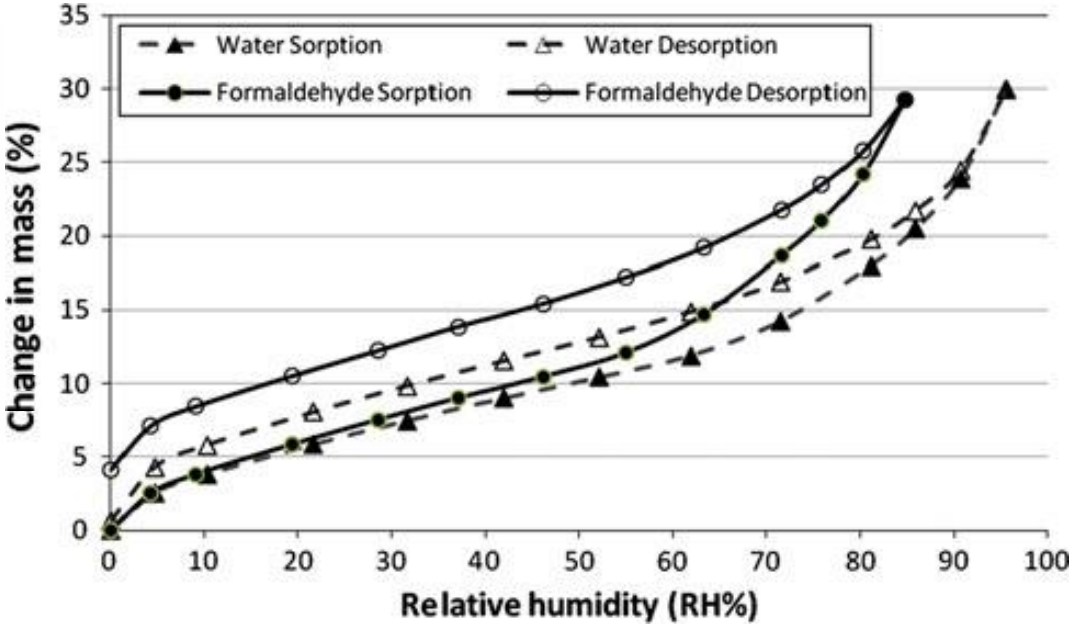
European regulations and schemes

Limit concentrations	Germany (Ausschuss zur gesundheitlichen Bewertung von Bauprodukten (AgBB), 2012)	Belgium (Federal Public Service Of Health, Food Chain Safety And Environment, 2012)	France (Ministère De L'écologie, Du Développement Durable, Des Transports Et Du Logement, 2011)	Finland (Finnish Society of Indoor Air Quality and Climate, 2010)
TVOC	1,000 µg/m^3 µg/m^3 after 28 days of storing in test chamber	1,000 µg/m^3 after 28 days of storing in test chamber	2,000 µg/m^3 for class B 1,500 µg/m^3 for class A 1,000 µg/m^3 for class A$^+$	200 µg/m^{2}h for class M1 and 400 µg/m^{2}h for class M2
Formaldehyde	100 µg/m^3 after 28 days of storing in test chamber	100 µg/m^3 after 28 days of storing in test chamber	120 µg/m^3 for class B 60 µg/m^3 for class A 10 µg/m^3 for class A$^+$	50 µg/m^{2}h and 125 µg/m^{2}h for class M2
Acetaldehyde	1,200 µg/m^3 after 28 days of storing in test chamber	200 µg/m^3 after 28 days of storing in test chamber	400 µg/m^3 for class B 300 µg/m^3 for class A 200 µg/m^3 for class A$^+$	-

Maximum allowable concentrations of VOCs set by European regulations and schemes

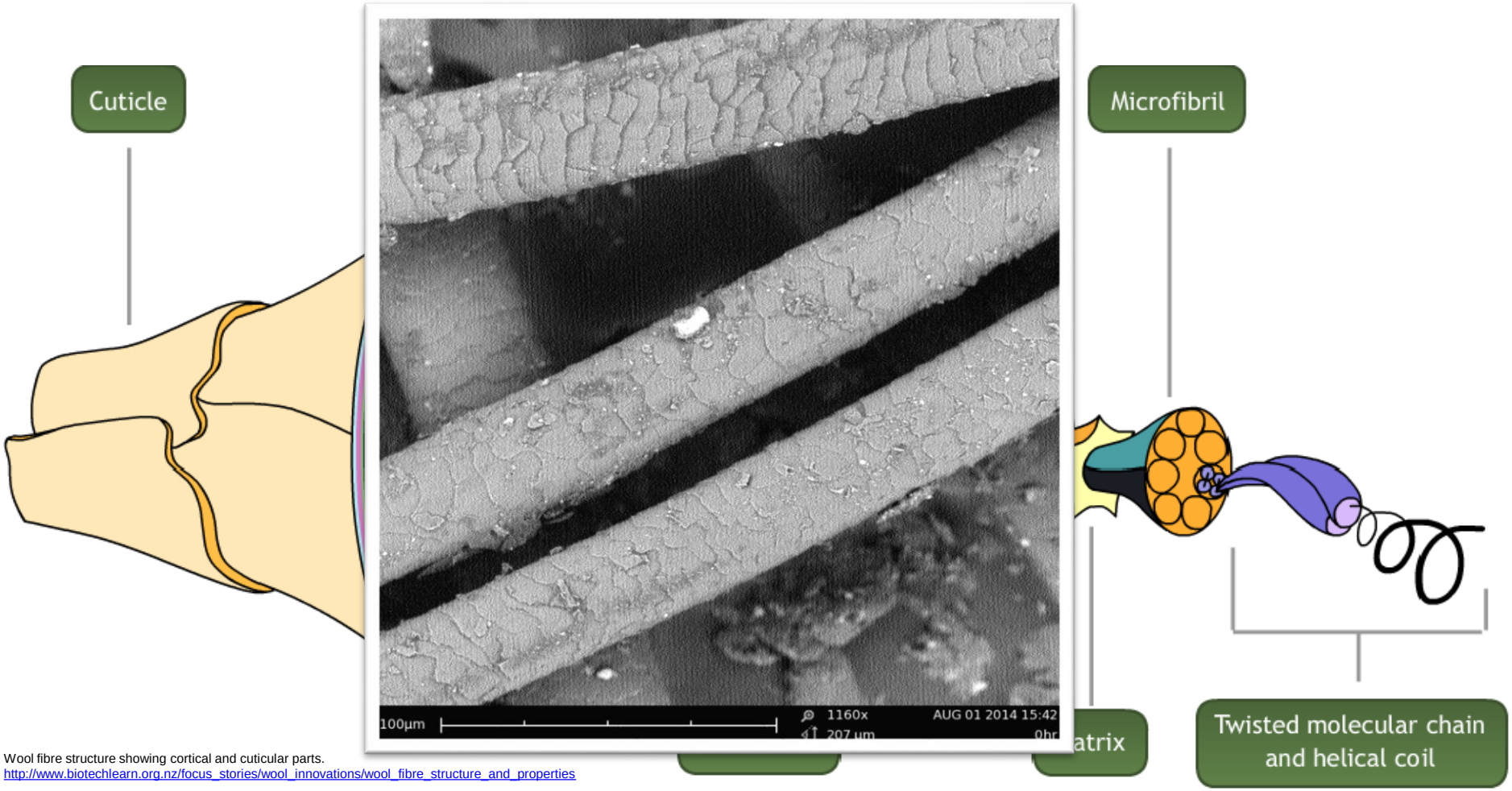
Why wool?

- 4.9% by weight absorbed
- 2/3 permanently bound



CURLING, S.F., LOXTON, C., ORMONDROYD, G.A. (2012): A rapid method for investigating the absorption of formaldehyde from air by wool. J. Mater. Sci: 47: 3248–3251

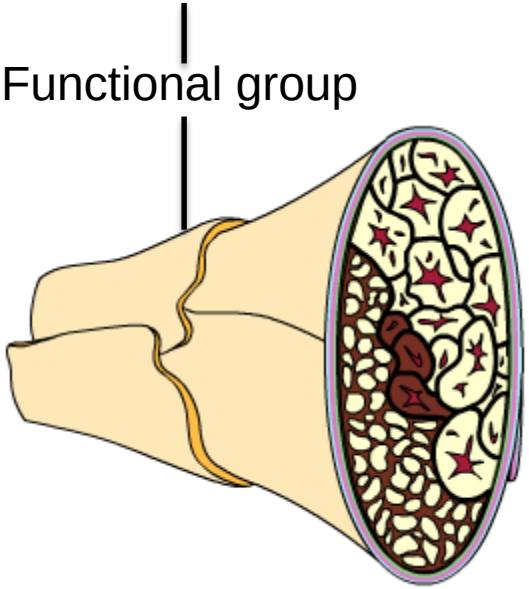
What is wool?



Wool fibre structure showing cortical and cuticular parts.
http://www.biotechlearn.org.nz/focus_stories/wool_innovations/wool_fibre_structure_and_properties

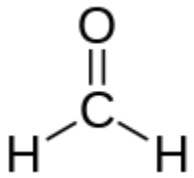
Absorption

VOC

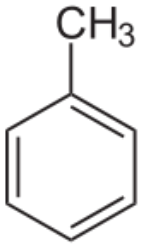


Which VOCs?

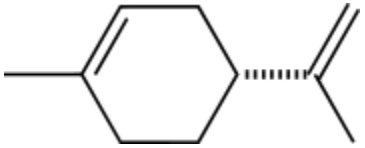
- Formaldehyde



- Toluene

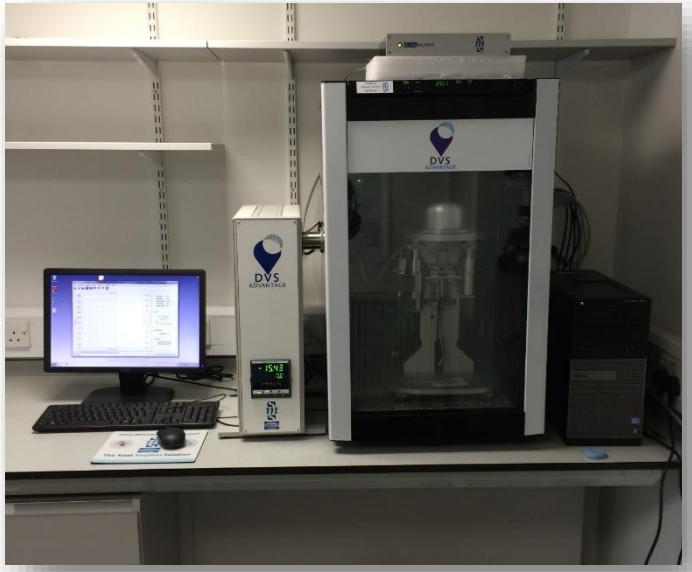


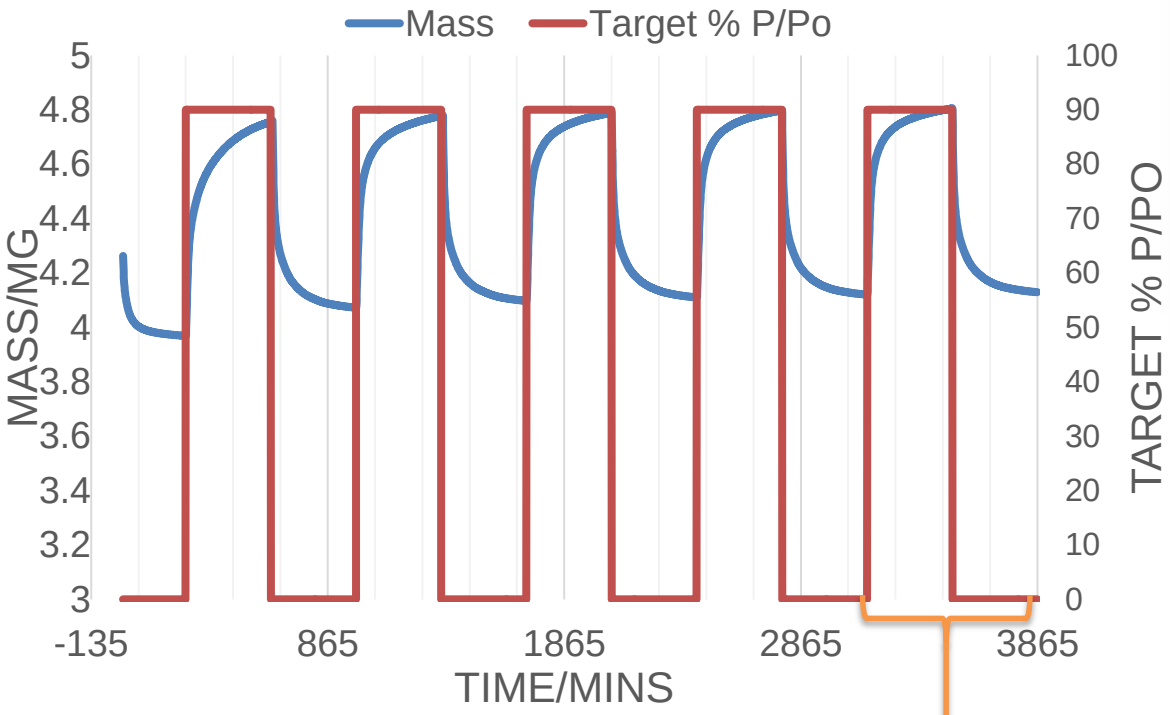
- Limonene

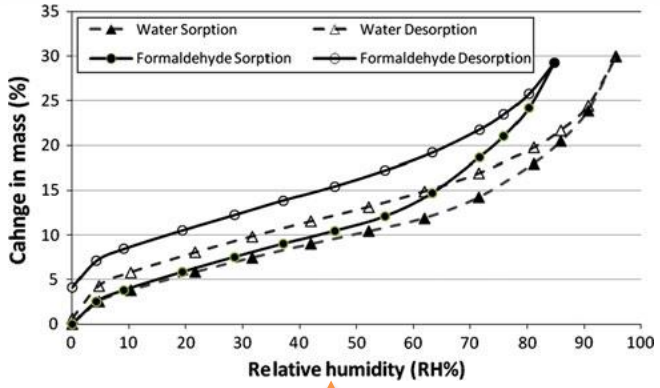


- Dodecane

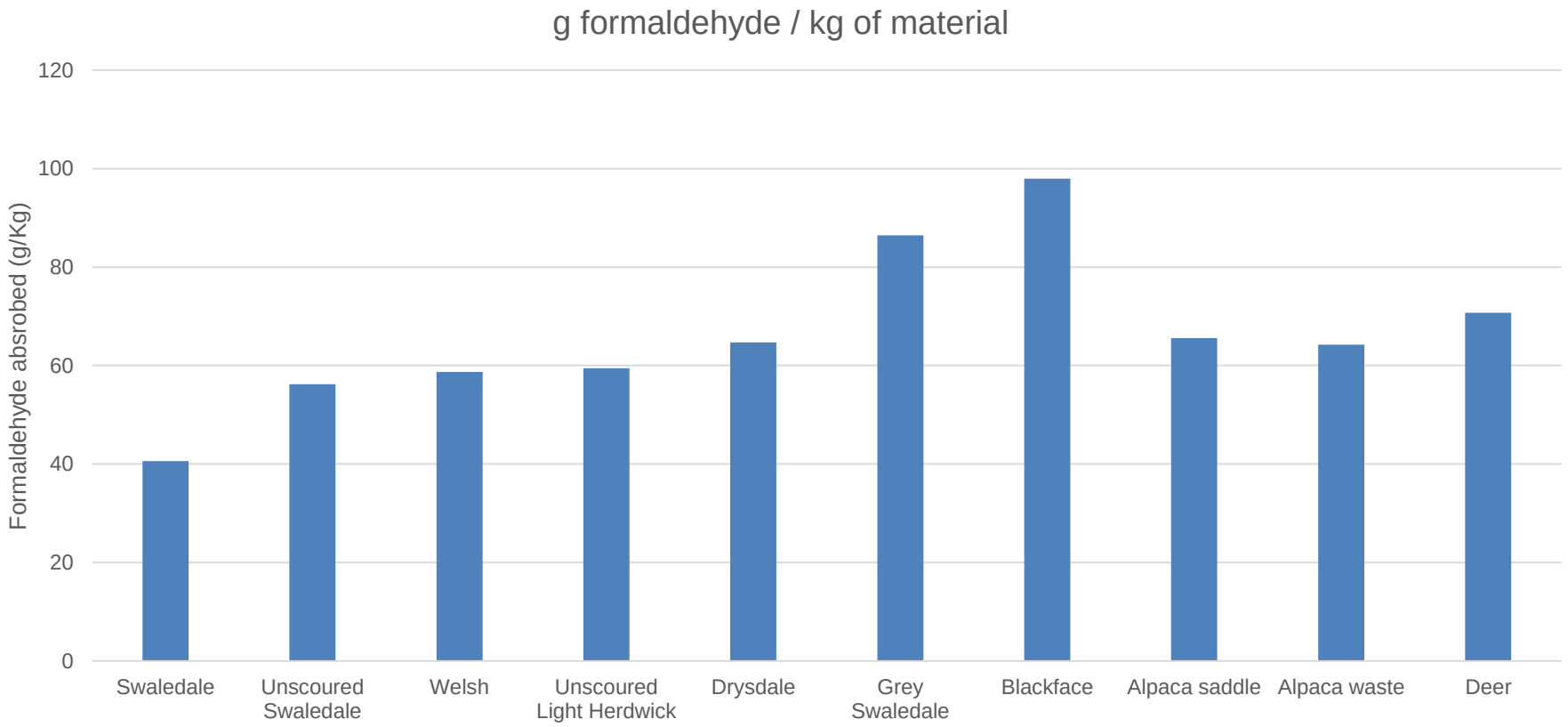
Formaldehyde analysis



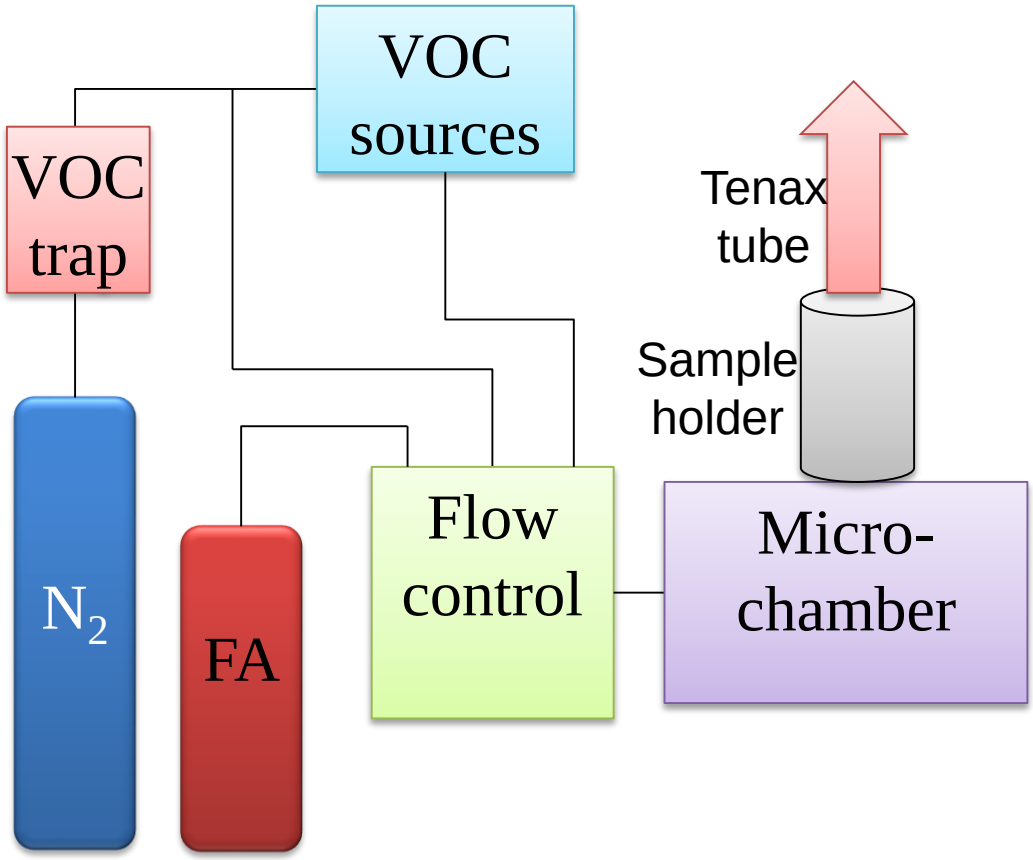


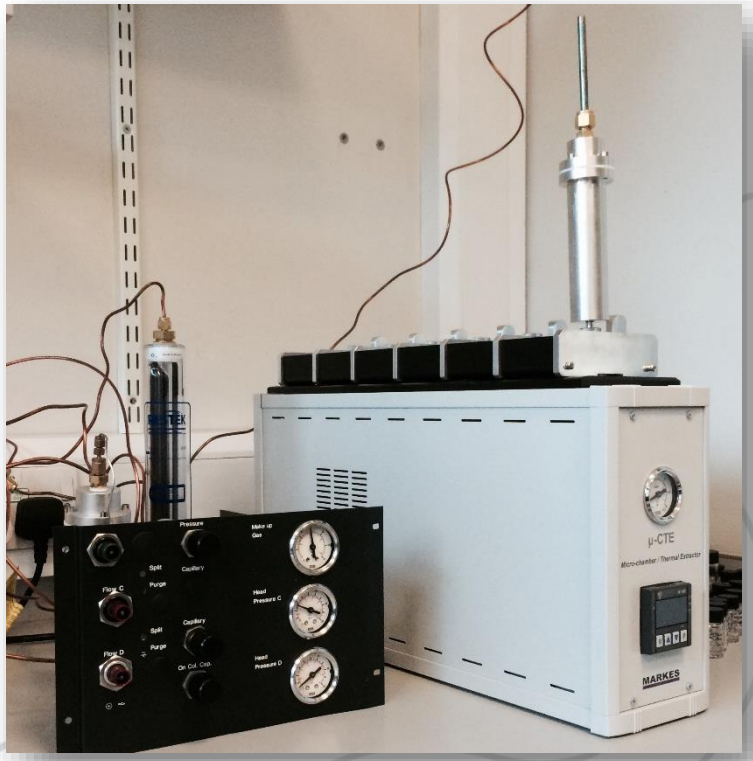


DVS results

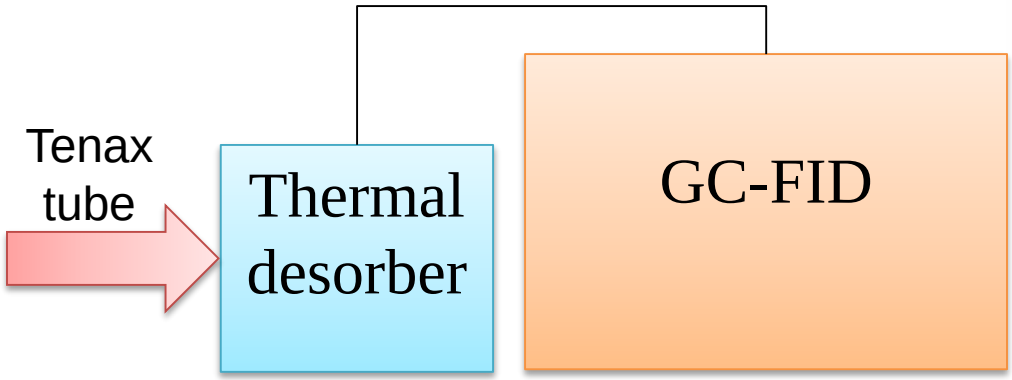

g formaldehyde / kg of material
Formaldehyde absrobed (g/Kg)
120
100
80
60
40
20
0
Swaledale
Unscoured Swaledale
Welsh
Unscoured Light Herdwick
Drysdale
Grey Swaledale
Blackface
Alpaca saddle
Alpaca waste
Deer

Toluene, limonene and dodecane analysis



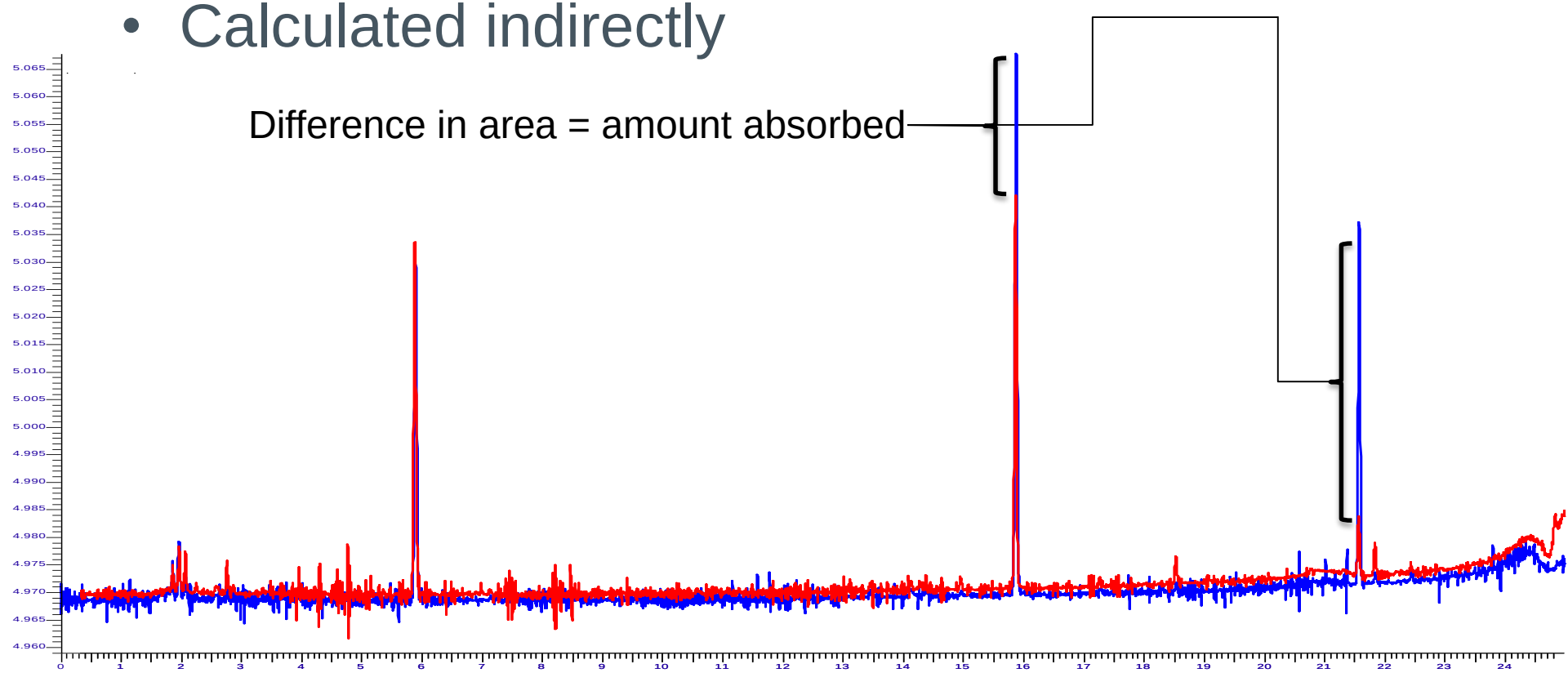


Thermal desorber



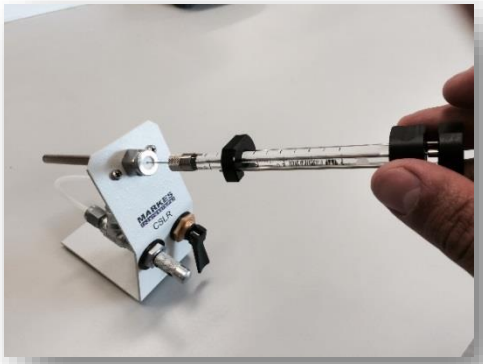
Chromatograms

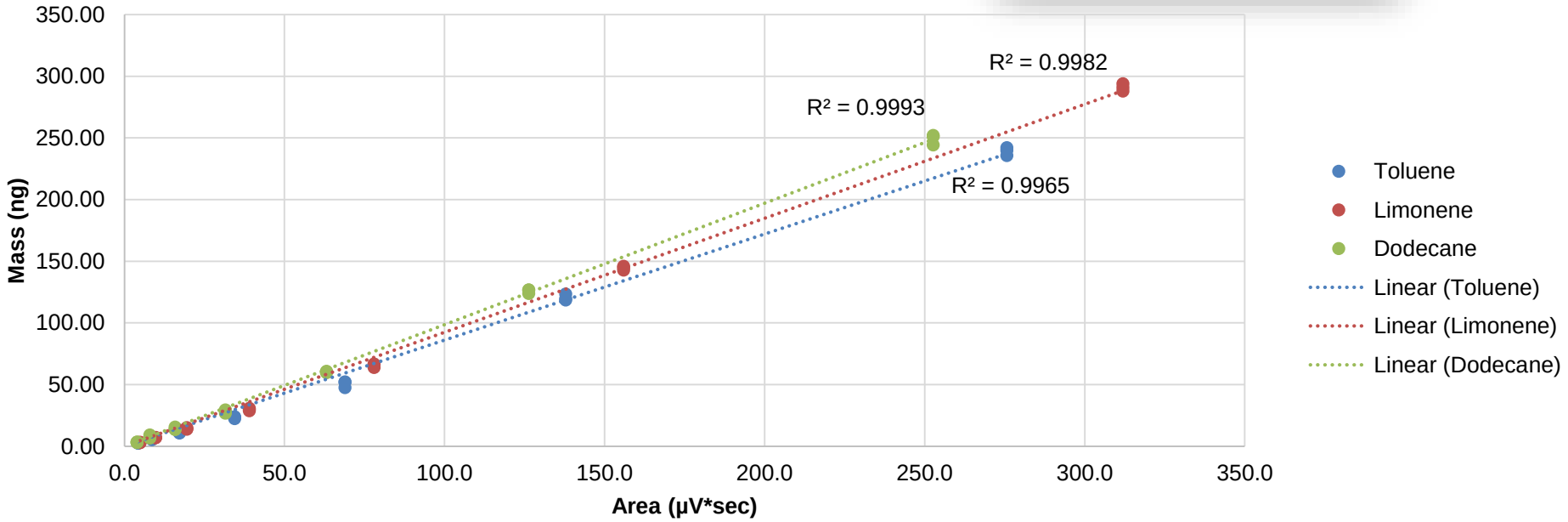
- Calculated indirectly



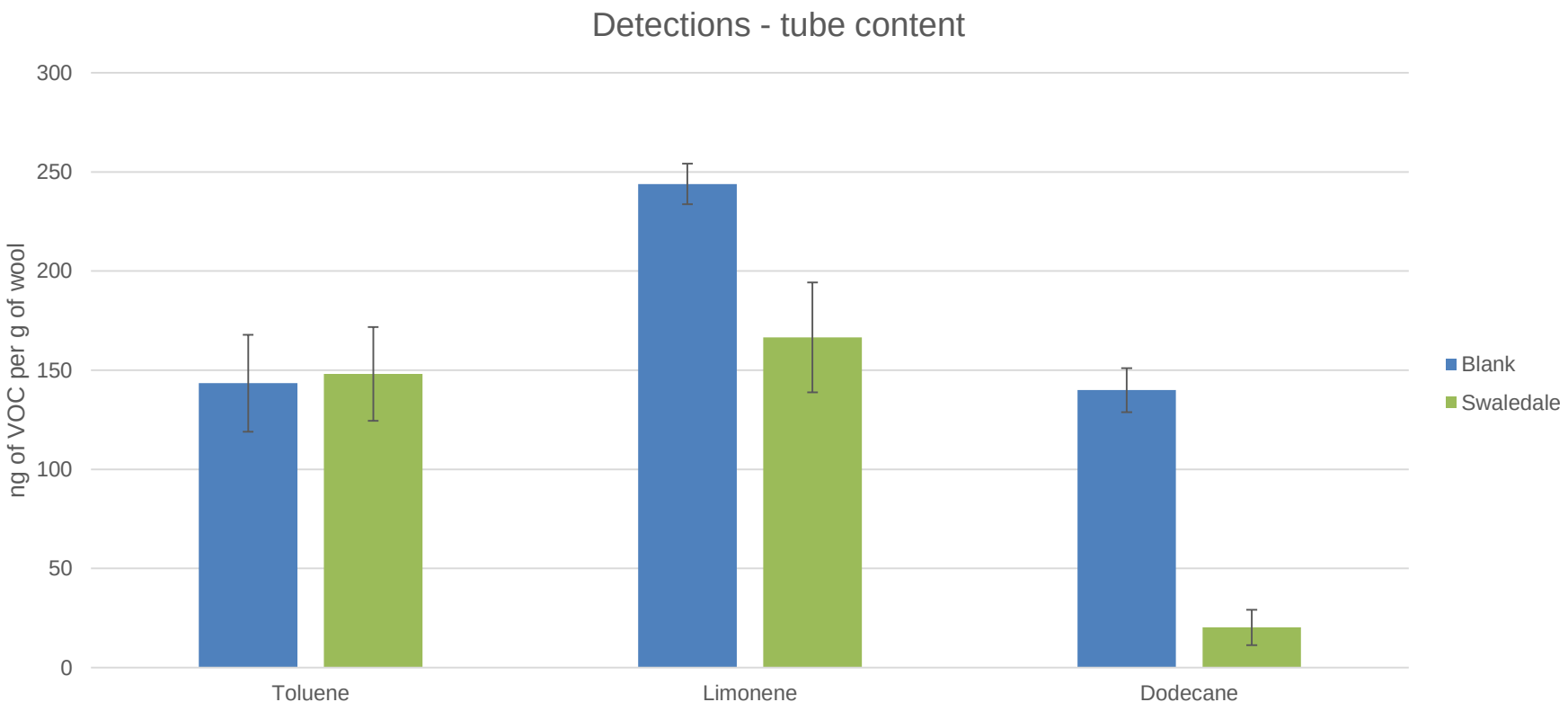
Chromatograms

- Calibration

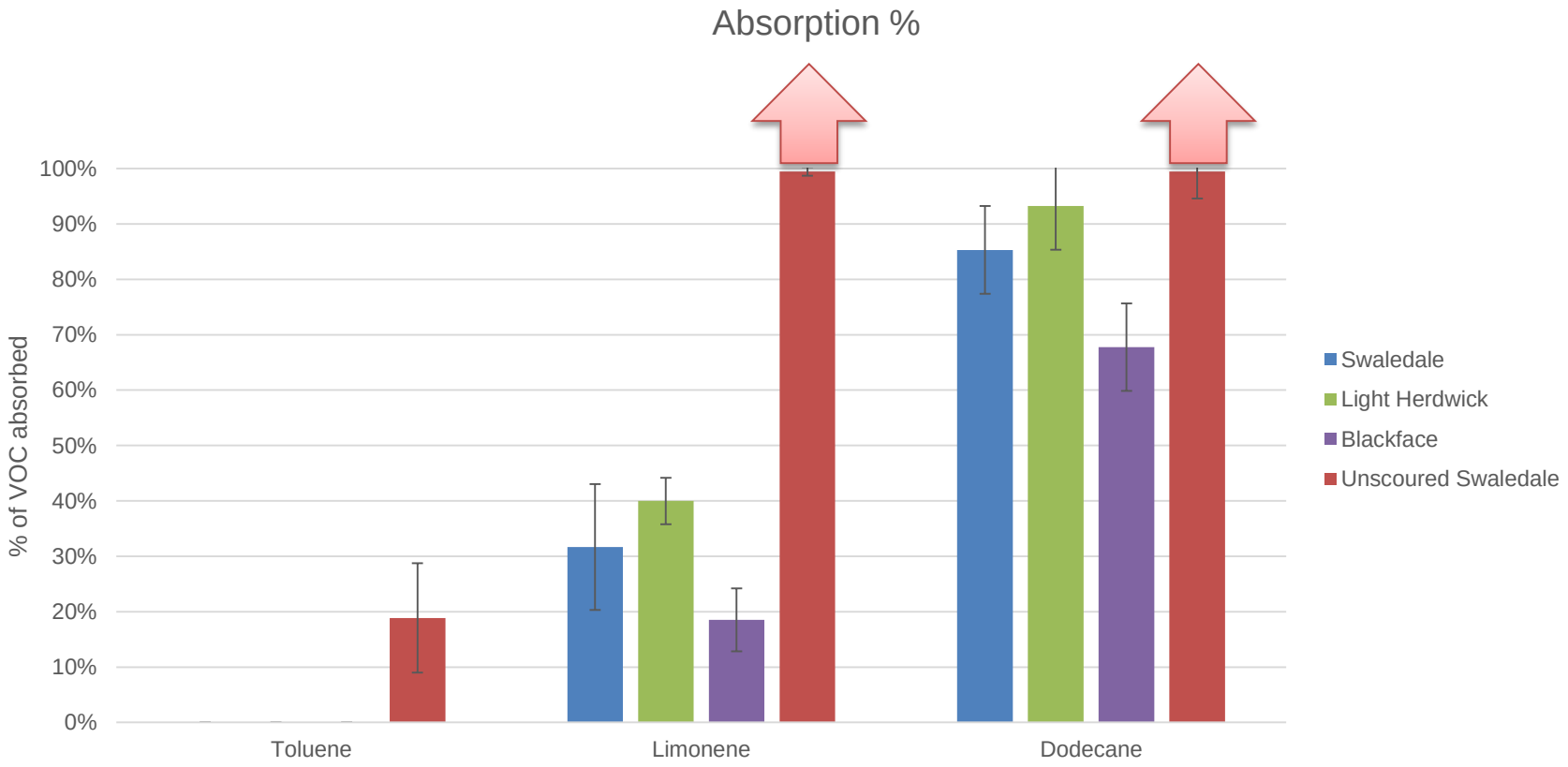




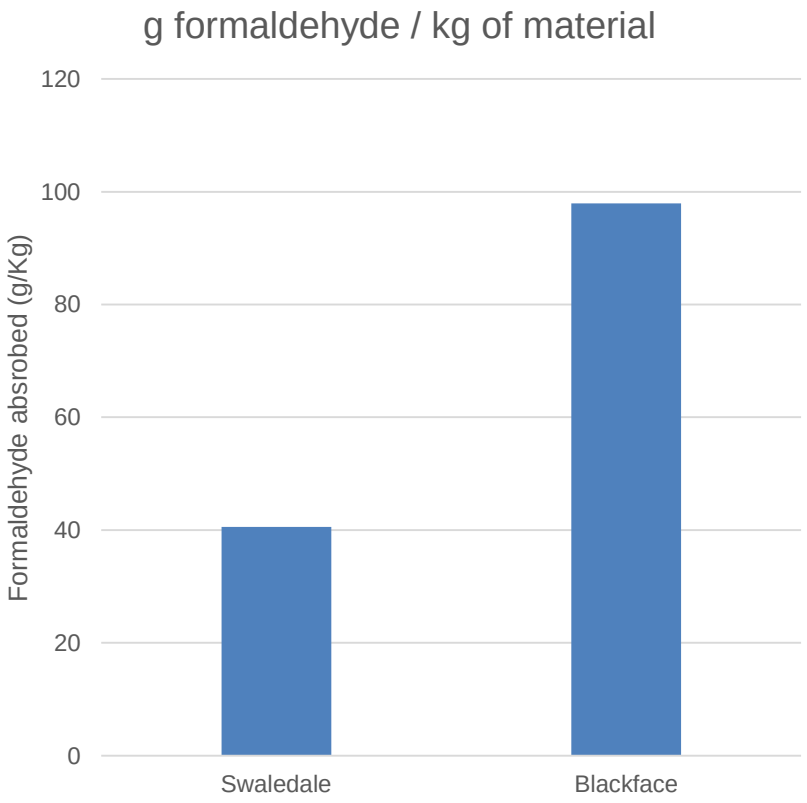
Results

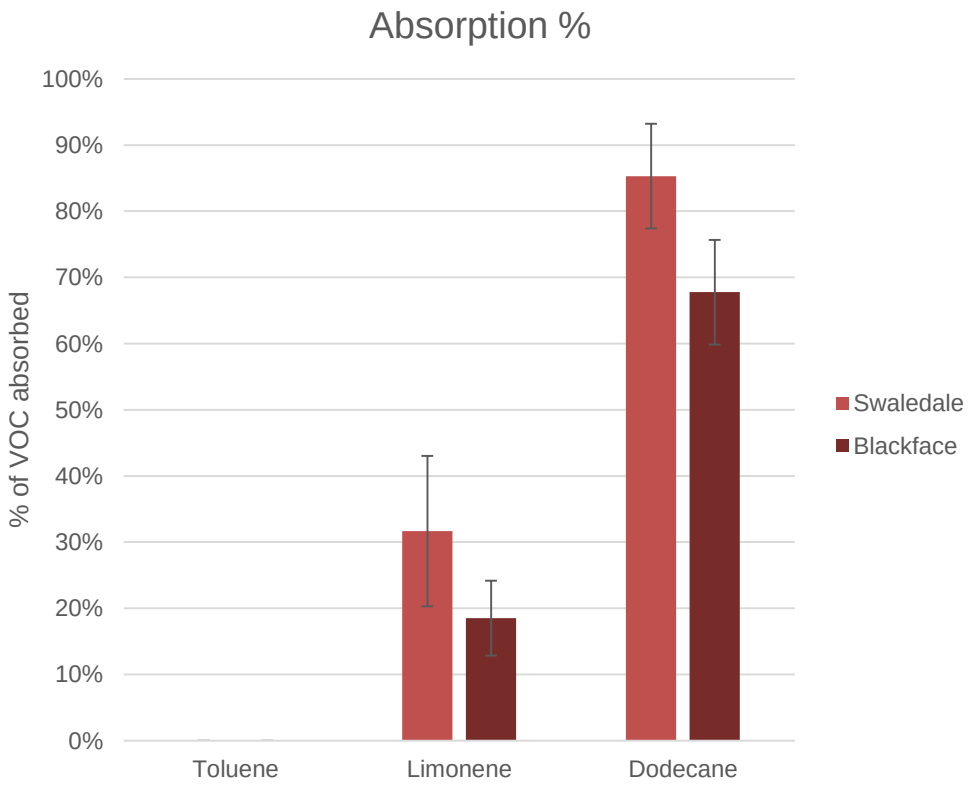

Detections - tube content
300
250
200
150
100
50
0
ng of VOC per g of wool
Toluene
Limonene
Dodecane
Blank
Swaledale

Results


Absorption %
% of VOC absorbed
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Toluene
Limonene
Dodecane
Swaledale
Light Herdwick
Blackface
Unscoured Swaledale

Comparison of results





Conclusions

- Wool types show different absorption charactaristics
  - Wool type selection → tailored absorption
- Unscoured wool absorbs more
  - Scouring of wool seem to lessen absorption potential probably due to lack of lanolin/contaminant or modification
- Wool surface polarity linked to absorption properties

The research leading to these results has received funding from the European union's seventh framework programme (FP7/2007-2013) for research, technological development and demonstration under grant agreement no 609234.

ECO-SEE

Black Mountain NATURAL INSULATION

Thanks for the wool!

WOOL TESTING AUTHORITY (EUROPE) LTD

WOOLCOOL

Thank you